



Workshop Report

Improving Knowledge of Connections Between Urban and Hinterland Systems

4th Annual Resilience Colloquium (RC4)

NSF Sustainable Urban Systems Grant #1929769

August 6 & 7, 2019

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A. Summary

The 4th Annual Resilience Colloquium (RC4) was held at the University of New Mexico on August 6 and 7, 2019. The goal of the workshop was to improve understanding of the interconnections between Sustainable Urban Systems (SUSs) and the rural communities and landscapes on which they depend and impact. RC4 was supported by an NSF Sustainable Urban Systems Conference and Workshop Award (#1929769) along with support from the New Mexico Department of Transportation (NMDOT) and the One Hundred Thousand Strong in the Americas (100K Strong) Program.

Urban systems, their surrounding landscapes, and rural communities are intricately linked. Perhaps nowhere is this more clear than in the intermountain western United States, where cities (e.g. Albuquerque, Phoenix, Denver, Boise, Salt Lake City, Las Vegas, etc.) dot vast landscapes containing isolated rural communities. The urban systems depend on rural systems for drinking water supplies, energy generation, food production, and other ecosystem services. Likewise, rural communities and landscapes are strongly impacted by the economic, political, and cultural forces of adjacent urban systems. The connections between urban and rural systems are shaped by engineered, natural, and cyberinfrastructure systems along with social, political, and legal systems. This workshop explored the connections between urban and rural systems to advance basic theory and applied knowledge of coupled sustainable urban and rural systems (C-SURS).

RC4 was structured around three guiding research questions: (Q1) How do changes in urban systems impact the resilience and adaptive capacity of rural communities and landscapes? (Q2) How do changes in rural systems impact the resilience and adaptive capacity of urban communities? and (Q3) How does the co-evolution of urban and rural systems decrease or enhance the overall resilience of the coupled system? The workshop agenda was shaped by a diverse steering committee composed of members from private industry, non-profit organizations, state and local government agencies, national labs, and academics. The workshop included 22 guest speakers with vast and diverse experiences, four discussion panels, three breakout sessions, networking breaks, and a special “Science meets Art” evening event. Highlights included a welcoming address by Congresswoman Deb Haaland (NM 1st District), a lunch address by U.S. Senator Tom Udall, and a lunch presentation by Dr. Ted Jojola and Michaela Shirley from the Indigenous Design and Planning Institute.

RC4 included 160 registered participants from a wide range of backgrounds, sectors, and perspectives. In addition, RC4 was attended by six students and five professors from the Universidad Tecnológica de Hermosillo (UTH) and Universidad de Sonora (UNISON), supported by funding from the 100 Thousand Strong in the Americas Program. Further, 25 students from the Instituto Politécnico Nacional (IPN) in Mexico City joined several components of RC4 including lectures and social activities. A return trip to Hermosillo, Mexico in November by four UNM faculty and three UNM students provided another opportunity to explore collaborative opportunities around the themes of RC4 with an emphasis on stressors facing C-SURS in arid and semi-arid environments. UTH and UNISON coordinated a resilience colloquium modeled after RC4 with a diverse array of speakers and fruitful discussion sessions.

The RC4 activities illuminated the challenges and opportunities facing both urban and rural systems, the interconnected nature of these systems, and urgent need to move quickly in building total systems resilience. The interdisciplinary, cross-sector, and systems-based emphasis of the workshop provided a broader perspective than many of the workshop participants had previously experienced, which led to lively and productive discussions through panel and breakout experiences. The diversity of rural and urban communities, the range of stressors facing these communities, methods for assessing resilience, and examples of approaches used to build resilience and adaptive capacity provided insights for a path forward and a research agenda to improve understanding of coupled sustainable urban and rural systems.

B. Background

RC4 was structured to build understanding of coupled sustainable urban and rural systems (C-SURS) using a resilience framework. Resilience theory has been advanced through several disciplinary tracks including ecology, engineering, and psychology. Through RC4, we approached our driving questions using socio-ecological systems (SES) resilience theory as originally conceived by Holling (1973) and further refined by Walker and Salt (2012) and others. As described below, however, the perspectives and approaches of individuals and organizations with respect to resilience theory and practice are highly diverse. These perspectives are expanded upon below *in Section E.1. Defining and Characterizing Resilience*.

Through RC4, we focused on the rural and peri-urban (fringe) areas that are interconnected with urban centers and suburbs (Zeev et al., 2014; Chen et al., 2018). We explored a variety of aspects of rural communities and rural landscapes, and the SESs that are formed by the interactions between communities and their landscape. Likewise, we investigated the socio-economic, governance, engineered, and natural components of urban systems. Interconnections between cities and the rural systems come in many forms including provisioning of resources (e.g. food, water, and energy) (Chen et al., 2018; Lant et al. 2019; Worstell & Green, 2017), cultural connectivity (e.g. economic ties, workforce exchange, exposure to natural hazards) (Fry et al., 2018), and more (e.g. Guo et al., 2018). These connections occur over a wide range of scales with great variability between sectors (e.g. energy, water, and health) and systems (Salvati & Serra, 2016).

The unprecedented migration of humans towards cities has been well documented (Bettencourt et al., 2007) and the impacts on cities remains an active area of research. However, the impacts on rural areas are less well understood. Challenges include a loss of cultural identity and resources, decreased populations of village centers and the countryside, reduced social services, and other socioeconomic challenges, including unemployment and substance abuse (Mahjabin et al., 2018). In at least some cases, these changes have reduced the resilience of rural systems to both natural and human-based disturbances (Padgham et al., 2015; Rushforth & Ruddell, 2016). Because of the strong interconnections between rural systems and cities, the loss of resilience in rural systems will likely decrease resilience of associated urban systems. For example, decreased forest health, increased wildfire frequency and severity, and increased energy production (e.g. fracking) in rural settings all have a strong potential to impact the security of urban water supplies (Paton & Tedim, 2012; Paveglio et al. 2014). As described by Bryant et al. (2017), the rural systems have room for ecosystem services to replenish clean water and fresh air, and for primary productivity to supply food, energy, and materials for hungry cities.

RC4 contributed to the following questions as identified in NSF's Advisory Committee for Environmental Research and Education (ACERE, 2018) report on Sustainable Urban Systems:

- (1) How do socio-environmental changes across urban to rural gradients of communities increase or reduce the resilience, well-being, and distribution of benefits across urban and rural communities?
- (2) What is the impact of changes arising in urban areas on local well-being, on the transboundary distribution of benefits and burdens across communities (urban and rural), and on planetary boundaries?
- (3) How can we systematically understand the functioning of cities and urban areas as multiscale, interdependent, adaptive systems, with interactions among social, natural, and engineered systems shaping multiple sustainability outcomes across scales?

C. Steering Committee and Summary of Participants

RC4 was planned and implemented by a diverse organizing committee that included members of academic, industry, government, and not-for-profit institutions with intellectual and applicable interests in resilience theory and practice. Table 1 includes the names and affiliations of each RC4 committee member. Local and federal government agencies were represented by the City of Albuquerque, U.S. Bureau of Reclamation, and Sandia National Laboratories. The Nature Conservancy and the LOR Foundation (mission to empower rural communities to solve local and regional problems) represented important not-for-profit committee members. Industry perspectives were represented by the Global Water Policy Project (mission to advocate for the conservation of fresh water through research, writing, and outreach) and RS21 (Resilient Solutions for the 21st Century). Finally, an undergraduate (Abadi) and a graduate student (Jones) were asked to join the panel, along with the PIs of this proposal (Stone and Morrison). The committee held monthly conference calls for the five months leading up to the workshop. The committee also assisted with recruiting speakers and coordinating and serving on discussion panels.

Table 1. Organizing Committee for the 4th Annual Resilience Colloquium

<i>Committee Participant</i>	<i>Affiliation</i>	<i>Role</i>
Mark Stone	University of New Mexico	Chairperson (PI)
Ryan Morrison	Colorado State University	Chairperson (PI)
Mahmoud Taha	University of New Mexico	Committee Member (co-PI)
Jake Caldwell	LOR Foundation	Committee Member
Roger Ebner	City of Albuquerque	Committee Member
Collin Haffey	The Nature Conservancy	Committee Member
Thushara Gunda	Sandia National Laboratories	Committee Member
Dagmar Llewellyn	Bureau of Reclamation	Committee Member
Sandra Postel	Global Water Policy Project	Committee Member
Josh Vertalka	RS21	Committee Member
Michaela Jones	University of New Mexico	Graduate Representative
Niloo Abadi	University of New Mexico	Undergraduate Representative

D. Summary of Workshop Framework and Agenda

RC4 was organized around the following three guiding questions.

- Q1: How do changes in urban systems impact the resilience and adaptive capacity of rural communities and landscapes (the hinterlands)? For example, how do water transfers from rural to urban settings impact the economies and cultures of rural communities?
- Q2: How do changes in the hinterlands impact the resilience and adaptive capacity of urban communities? For example, how has the decline in forest health (e.g. tree dieback and increased wildfire activity) impacted water supply reliability and exposure to flood risks?
- Q3: How does the co-evolution of urban-hinterland systems decrease or enhance the overall resilience of the coupled system?

The agenda was designed to first introduce the participants to the definitions, principles, and practices of resilience and then to explore each of these questions one-by-one. Discussion panels, break-out periods, and social activities were integrated into the colloquium to allow opportunities for digesting and integrating information and consideration of future steps. High-profile speakers were invited to address the audience to emphasize the pressing nature of these issues. The full agenda is included in Appendix A, along with links to the speakers' PowerPoint presentations.

E. Summary of Activities

E.1. Defining and Characterizing Resilience

RC4 participants provided a wide range of definitions and interpretations to the application of resilience principles within the context of their work including the following:

- The ability to absorb and adapt in a changing environment (including shocks and stresses)
- The capacity of a system to absorb a spectrum of disturbances and reorganize so as to retain essentially the same function, structure, and feedbacks—to have the same identity.” (from Walker and Salt 2012)
- The capacity to survive, adapt, and thrive in the face of stresses and shocks
- Positioning yourself to deal with the unexpected – preventing a problem from becoming a disaster
- Preparing to deal with unexpected shocks and stresses elegantly
- Resilience is a strategic enabler. It is a characteristic of a city, its communities, infrastructure, economy, governance and institutions that enables future progress and prosperity, without succumbing to or being deflected by disruption through shocks or stresses.

A common theme that emerged amongst the participants was in describing resilience of a system with respect to coping with and responding to a stress or disturbance. This theme included an emphasis on using holistic and systems-based perspectives when evaluating resilience. Individual perspectives were clearly influenced by the nature of an individual’s experience and/or the mission of their organization. Several of the participants also advanced the idea of viewing resilience beyond surviving, responding, or rebounding (etc.), but rather to aspire to a condition where systems *thrive*. The concepts of systems theory were also discussed with an emphasis on socio-ecological systems (SES) and coupled natural and human systems (CNH).

Several concepts that support resilience principles were discussed and explored, including: moving away from stationarity principles; the cycle of renewal and disturbance of SESs; interconnections across spatial and temporal scales; specific vs. general resilience; and thresholds and transformation. In many contexts, transformation is considered to be an undesirable outcome of system adaptation, but RC4 participants discussed the inevitability of transformation in some instances and the need for leaders to embrace and prepare for transformation in such situations. A vivid example was provided by Dagmar Llewellyn from the U.S. Bureau of Reclamation when she described the changing forest landscapes in New Mexico under warmer and dryer conditions that are leading to vegetation dieback, increased wildfire conditions, and vegetation transitions (e.g. forests to shrublands).

Speakers, panelists, and participants also explored the ideas of characterizing systems resilience and the aspects of systems that provide or enhance resilience. Several frameworks were presented, ranging from fairly simple (conceptual) to detailed methodologies. At the conceptual level, the process includes defining and characterizing the system (e.g. infrastructure and the environment), defining the system’s institutions (e.g. laws, norms, and culture), identifying stressors (chronic, such as poverty, versus acute, such as natural disasters), and investigating the system’s ability to cope with those stressors. A detailed process was shared by Heather Rosenberg of ARUP, based on the 2019 City Resilience Guide from the UK, with the following specific process steps:

- (1) Organize and Define: Governance Arrangements – Engagement of stakeholders, empowering citizens and organizations & identifying shared values and goals
- (2) Assess and Prioritize: Identifying and describing shocks, stresses, and trends, characterizing system demand and capacity, identifying knowledge and data gaps, and prioritizing issues

- (3) Plan and Prepare: Developing a resilience strategy and associated options, building the business case, and securing funding
- (4) Partner and Deliver: Managing programs, building capacity, and raising awareness
- (5) Continuously Improve: Re-assess, reflect, learn, innovate, and improve

The overarching goals of following a process like this are to build adaptive capacity and to continuously evaluate, learn about, and improve the resilience of the system. Examples were provided from a wide range of systems and specific examples from rural, urban, and C-SURS are provided in the following sections.

Identifying characteristics that define a resilient system depend on the system type. In general, RC4 participants identified the following characteristics of resilient systems types:

- (1) Resilient systems (in general): Possess the ability to learn, resourcefulness, flexibility, diversity, highly integrated, transparency, equity and inclusivity, robustness, and redundancy and/or modularity.
- (2) Resilient Institutions: Understanding of rights and entitlements, transparent, representative and fair decision-making, and access to information for planning and decision-making.
- (3) Resilient Communities: Responsiveness, capacity to learn, relationships and social networks, resourcefulness, and empowerment to act on that resourcefulness

Karen McClune of ISET emphasized the power to gain insights via forensic investigations after disasters including examples from the September 2013 floods in Boulder, Colorado and the devastating impacts of Hurricane Harvey and Hurricane Katrina. A key insight provided by Karen was that events are elevated to disasters as a result of planning failures, regulatory framework failures, maintenance failures, structural failures, communications failures, failures to anticipate and work with change, and failures of imagination. As she described, “In many cases, we are continuing to build in high hazard areas and in many cases providing economic incentives to do so.” More attention needs to be given to the risks associated with natural hazards to build awareness and capacity of residents, jurisdictions, and first responders. **Another key element of resilience is recognizing that things will fail...and planning for the inevitable failure.**

E.2 Learning about the characteristics, resilience, and adaptive capacity of rural systems

RC4 participants had the pleasure of hearing from a diverse group of speakers and panelists representing Native American communities, traditional irrigation communities, modern irrigation districts, water and energy utilities, and experts on rural transportation systems. **A clear theme that emerged is that rural communities are diverse, their opportunities and strengths are diverse, and their challenges are diverse.** We’ll briefly summarize some of these diverse perspectives here.

Rural places have histories that have been shaped by material features and people have transferred their cultures to and from rural places. As a result, rural regions are abundant with cultural diversity. As summarized by Dr. Benjamin Warner (UNM Geography), “Objectively, we know that rural spaces cannot be defined with a broad brush, but we often seem to ignore the nuance and pluralism that exists across these spaces as we label them with terms like countryside, country, wilderness, outback, agricultural, campo, and so on – these terms live in the popular imagination of our society. The rural stands as a significant imaginative space within the psyche of the Western world, where romantic ideas develop and portray these spaces as idyllic, oppressive, as a thing to be conquered, or as a thing to be defended.” However, as Dr. Warner and others pointed out, in spite of the diversity in cultures, places, communities, landscapes, etc. this pluralism is often overlooked. This is problematic in development policy and especially true with respect to underserved and minority populations both in the United States and in the developing world.

Dr. Manuel-Julian R. Montoya (UNM Business School) provided a helpful historical perspective on the history of views on cosmopolitanism and its conflation with “urban.” That is, aligned with the development of the human-centric orthodoxies of Economies of Scale (1770s) and Economies of Density (1980s). In short, these concepts are built on the principle that outputs are increased and costs are decreased by increasing scales (growing a market) and reducing spatial proximity. This drives innovation and productivity and turns cities into economic engines. In this context, the rural tends to be viewed as quant, backwards, and behind-the-times. However, as argued by Dr. Montoya, rural spaces have value, both in this human-centric view and otherwise. These values simply don’t conform to human-centric models of progress. Rural spaces are not empty, desolate spaces just because they have small human populations. Acknowledging the narrowness of traditional economic (human-centric) views of the urban vs. rural gets us to rethink economic and scientific objectives.

The influences of complex histories, the resulting plurality of rural communities and landscapes, and the shortcomings of human-centric economic models are illustrated in vivid fashion through the perspectives of Indigenous populations. This is particularly true in New Mexico and the American Southwest, but similar conditions are observed all over the world. Janene Yazzie provided extremely valuable insights of the progress and challenges to achieving sustainability and environmental justice for Native American communities and the international context for these efforts. As described in the United Nations *Indigenous Peoples Major Group for Sustainable Development Global Report on The Situation of Lands, Territories, and Resources of Indigenous Peoples*:

1. Indigenous peoples have the right to the lands, territories and resources (LTR) which they have traditionally owned, occupied or otherwise used or acquired
2. Indigenous peoples have the right to own, use, develop and control the lands, territories and resources that they possess by reason of traditional ownership or other traditional occupation or use, as well as those which they have otherwise acquired
3. States shall give legal recognition and protection to these lands, territories and resources. Such recognition shall be conducted with due respect to the customs, traditions and land tenure systems of the indigenous peoples concerned

Because Indigenous LTRs are typically located in rural spaces, but with intricate ties to urban areas, *“We have an opportunity to comprehensively re-evaluate and re-imagine our development future for New Mexico’s urban, rural and Native American Communities that protects the LTR and sacred spaces of Indigenous Peoples for the benefit of our ecological sustainability, resiliency, and for the prosperity of future generations.”* Janene Yazzie

An acequia is a community-operated watercourse, and the associated social and governance structure that manages it, used in Spain and former Spanish colonies in the Americas for irrigation. Acequias are woven into the landscape, history, culture, and identity of rural communities in New Mexico. Paula Garcia, Director of the New Mexico Acequia Association, shared her perspectives on the resilience and challenges faced by the state’s acequias. The resilience and sustainability of New Mexico’s acequias is rooted in history, self-determination, leadership, and imagination. The 640 acequias in New Mexico support local and regional food systems, contribute to the state’s economy, and support infrastructure and ecosystem services. Acequias provide a model for water sharing in times of shortage through centuries of customs and adaptability. The resilience of acequias is challenged by water market forces (transfers to rural areas), depletion of water supplies, reduced water quality, and climate change.

Expanding briefly on water sharing practices, water appropriations in the intermountain western United States is usually managed via the “prior appropriations doctrine.” That is Priority in time shall get the better right, and during very dry years, senior water rights get their water first and those with junior water rights may get less or no water. In contrast, acequias handle water shortages via shared-shortage practices. Acequia systems are therefor, better suited for drought-prone regions and can serve as a model for reforming water shortage practices.

Modern irrigation districts also face their fair share of challenges, including: volatile markets, increasing competition from municipal and industrial water users, environmental issues, persistent drought, increased aridity (in the southwestern U.S.), and legal challenges in meeting obligations. Upkeep and replacement of aging infrastructure is increasingly difficult to manage. For example, El Vado Dam is a critical storage reservoir for the Middle Rio Grande Conservation District. However, this 90-year old dam does not meet safety standards and it will cost millions of dollars to bring it into compliance. Another vivid example of the challenges faced in management of irrigation water in the region comes in the form of the pending lawsuit between the states of New Mexico, Texas, and the U.S. Department of the Interior over the accusation that New Mexico has over-extracted its rights to water under the Rio Grande Compact.

Rural water utilities also face many of these same problems as highlighted in a presentation by Dr. Ben Warner. In New Mexico, hundreds of small water utilities are faced with challenges in maintaining water supplies including the impacts of wildfires and floods, reliance on sole sources, impacts of extended droughts and groundwater drawdown, and water contamination (often from legacy activities such as abandoned mines). Further, they face social challenges including shrinking populations, poverty, aging operators and overall lack of expertise, and administrative burdens for maintaining compliance and defending water rights. Within New Mexico, these challenges have led to a push for strategies that promote collaboration of operations, management, or infrastructure between neighboring public water systems. Regionalization brings its own opportunities and challenges.

E.3 Learning about the characteristics, resilience, and adaptive capacity of urban systems

RC4 participants heard from an array of experts on the topic of urban systems resilience in the afternoon session of Day 1. As was the case for rural systems, the wide range of experiences of the speakers and panelists illustrated the diversity of urban systems, approaches to characterizing systems resilience, and approaches that can be used to build adaptive capacity. The speakers shared their perspectives for the characteristics that are desired to build the resiliency of urban systems including: flexibility, robustness, redundancy, resourcefulness, reflectiveness, inclusivity, and integration. The “urban perspectives panel” emphasized the necessity for resilience leaders who work to maximize co-benefits, creatively identify potential failure points, diversify critical infrastructure, and design for the most vulnerable members of their communities. **A key theme that became evident is that resilient cities have the hindsight to learn from the past and to recognize its strengths, weaknesses, values and direction, the insight to know what can and cannot be immediately controlled, and the foresight to anticipate and adapt such that it avoids or addresses future disruptions and change** (paraphrasing Caroline Field).

Within urban systems, population density, infrastructure, businesses, homes, and social structures create a focal point for risks and opportunities. Risks can materialize via sudden shocks (e.g. natural disasters) or chronic stressors (e.g. poverty). Shocks interrupt the services that people take for granted and which vulnerable people depend upon. Hence, acute and chronic stressors are uneven in their impact, disproportionately impacting poor and often minority community members. The shocks and stressors impose both human and economic costs and thus hamper growth and reduce opportunities. In many cases, both acute and chronic stressors are being exacerbated by climate change including increased summer temperatures (increased heat stress and cooling costs) and increased frequency and severity of extreme events. These challenges become more acute as cities grown in population.

Dr. Melissa Bilec from the University of Pittsburgh provided a vivid example of building urban resilience from Pittsburgh. Her presentation was titled “A Tale of Two Cities (Pittsburgh): Exploring Sustainability and Resilience Opportunities and Challenges,” and she highlighted the stark contrast between the wealthy and poor (primarily minority) neighborhoods in the city. As is often the case,

historical and ongoing social and environmental injustices have driven inequalities in the neighborhoods of Pittsburgh. As one of the Rockefeller Foundation 100 Resilient Cities, Pittsburgh aims to “be resilient when the city is livable for all residents.” In this setting, community-based research and community action teams are being used to address environmental justice problems concerting air pollution through a more transparent and equitable urban transportation planning process.

Another powerful example for assessing and planning for resilience was provided by Caroline Field. Beirut, one of the oldest cities in the world, is a key trading port with a complex and turbulent history. The city has been shaped by commerce, civil war, earthquakes, and tourism. An assessment and prioritization of the stressors facing Beirut revealed the challenges caused by poor infrastructure conditions, water shortages, influx of Syrian refugees, climate change, poor air quality, inadequate mass transit, inconsistent electricity, and inadequate governance. Resilience can be built through a detailed strategy to plan and prepare for shocks including earthquake risk reduction, coastal resilience, recovery planning, improved mobility, and building community resilience (e.g. increased equality and integration).

E.4 Ideas and examples for building resilience in coupled sustainable urban and rural systems

In spite of the many challenges facing rural and urban systems, RC4 participants shared a range of activities and opportunities for building resilience of coupled sustainable urban and rural systems. **An emerging theme was increased resilience through increased connectivity between urban and rural components of these coupled systems.** Connectivity comes in many forms including infrastructure, communications, digital technologies, natural resources management, and many other avenues. However, increasing connectivity in its various forms can also lead to unintended negative consequences including pollution, crime, and illicit trafficking.

Several examples of the tools, strategies, and policies for enhancing C-SURS resilience were provided that addressed socio-economic, infrastructure, and natural resources elements of the target systems. Dr. Olaf Kulke described the application of cultural entrepreneurship as a resiliency strategy for remote communities. The strategy of the programs is to build resilience using proven entrepreneurship programs from urban areas and adapt them to remote community needs. Through case studies in Morocco, Alaska, and northern Canada, Dr. Kulke described how cultural entrepreneurs can serve as cultural change agents and resourceful visionaries by organizing cultural, financial, social and human capital, to generate revenue from a cultural activity. Their innovative solutions result in economically sustainable cultural enterprises that enhance livelihoods and create cultural value and wealth for both creative producers and consumers of cultural services and products.

Through speakers, panels, and discussion sessions, RC4 participants explored the shifting paradigm for forest and shrubland management in New Mexico as a powerful example for developing resilience of C-SURs. As described by Dr. Matthew Hurteau, historical forest management in the U.S. emphasized wildfire suppression, which has led to extensive accumulation of fuel loads. Combined with a warming climate, excessive droughts, and increased human activity within forest settings, these practices have contributed to unprecedented wildfires with respect to size, severity, and frequency. The direct and follow-on impacts of wildfires (e.g. flash flooding, debris flows, loss of biodiversity, etc.) have been profound and costs now exceed billions of dollars per year. Downstream systems, including a large number of urban areas, have been profoundly impacted by forest wildfires. For example, the City of Albuquerque was forced to shut down its surface water withdrawals from the Rio Grande for 40 days following the Las Conchas Wildfire in 2011.

Innovative programs are being developed to reverse these damaging trends and to work towards more resilient coupled urban and rural systems. Two examples from New Mexico were explored through RC4. The Rio Grande Water Fund, spearheaded by The Nature Conservancy (TNC), is a

20-year public-private partnership with the goal of restoring 600,000 acres of forest in the Rio Grande headwaters to protect New Mexico's water supply. The program also aims to boost local economies and rural jobs and to educate youth and policy makers. Dr. Collin Haffey from TNC described the process of establishing the program and progress in meeting the restoration target, including the treatment of 33,000 acres in 2018. He also described the systematic process being employed by the program, via their forest council, to foster proactive management. The water fund is being financed nearly exclusively by investments from urban water utilities and irrigation districts and they currently boast of having more than 80 charter signatories.

Another positive example of leadership in building resilience in coupled urban and rural systems was described by Leslie Allison from the Western Landowners Alliance. Leslie was instrumental in the establishment of the Chama Peak Land Alliance in the headwaters of the Rio Grande. The alliance includes "a diverse group of conservation-minded landowners committed to embracing and practicing responsible land, water, and wildlife stewardship in southern Colorado and northern New Mexico for the benefit of our tri-cultural heritage and for generations to come." The alliance works to advance policies and practices that sustain working lands, connected landscapes, and native species. Like the Rio Grande Water Fund, the alliance benefits from significant support from allies in urban areas and working across sector and disciplinary boundaries.

F. Key Questions and Steps Forward

The RC4 activities illuminated the remarkable complexities and diversities in the rural and urban systems in which our participants work and live. Although it was not possible to reach firm conclusions for our thematic questions in a 1.5-day workshop, there were several salient themes that emerged that can help guide future steps. The following points stood out:

- (1) Both urban and rural systems are composed of remarkable plurality and diversity that are often underappreciated by people outside of these systems. Our tendency to simplify and group these complex systems contributes to misconceptions, at best, and misguided or damaging policies at worst. Future work needs to work towards methods to account for these complexities and diversities and ultimately to lead towards improved policies.
- (2) Our policies, projects, and areas of expertise tend to focus on either urban or rural systems but not on the interconnections and co-dependencies between systems. The speakers, panels, and discussion sessions generated copious amounts of information about rural and urban systems, but we made substantially less progress towards our main goal of improving understanding connections between the two. Future efforts could potentially gain insights in this area by more carefully structuring the workshop elements to elicit these aspects or by making a concerted effort to find experts at that interface. Further, it is obvious that more research and practice need to be focused at the interface between the two.
- (3) There are a range of stressors facing urban and rural systems. In many cases, the same stressor directly impacts both systems (e.g. aging infrastructure), where in other cases the stressor to one system has a secondary impact to the other system (e.g. wildfires). Further, the threats of these impacts are perceived as dire in many cases (e.g. extended drought in the southwest). Holistic systems approaches are desperately needed to address these stressors before they reach crisis stage.

A follow-on resilience colloquium was hosted by the Universidad Tecnológica de Hermosillo and Universidad de Sonora in November of 2019. Further, PI-Stone attended the SUS Workshop hosted by Temple University in September of 2019 that also focused on Urban-Rural linkages. In spite of the dramatically different settings of Philadelphia, Albuquerque, and Hermosillo (Mexico), many of the same themes, challenges, knowledge-gaps, and policy shortcomings were raised. This observation highlights the opportunities that exist in advancing research on coupled sustainable urban and rural systems.

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Appendix A: Resilience Colloquium Agenda

Note: Click on presentation titles to view the associated presentation files



Tuesday, August 6th

Session 1: Resilience Concepts and Discussions on Urban and Rural Systems

- 8:00 am-8:10 am** **Opening Remarks and Colloquium Goals**
 Mark Stone, UNM Resilience Institute
 Mahmoud Taha, UNM Civil, Construction & Environmental Engineering
 U.S. Representative Debra Haaland
- 8:10 am-8:30 am** [Overview of Resilience Concepts and Perspectives](#)
 Dagmar Llewellyn, U.S. Bureau of Reclamation
- 8:30 am-8:50 am** [Contextualizing Resilience in Rural Water Cultures and Institutions of the Southwest United States](#)
 Benjamin Warner, UNM Geography and Environmental Studies
- 8:50 am-9:10 am** [Rural Cosmopolitanism: Rethinking Economic Systems](#)
 Manuel Montoya, UNM Anderson School of Management
- 9:10 am-9:30 am** [Complexities of Building Resilience in the Peri-Urban Environment](#)
 Ken MacClune, ISET-International
- 9:30 am-9:50 am** [Sustainability and Resilience in the Built Environment](#)
 Heather Rosenberg, Arup
- 9:50 am-10:00 am** **Coffee Break in the Stamm Room**

Session 2: Resilience Challenges and Opportunities for Rural Communities and Environments

- 10:00 am-10:20 am** [Sustainability and Environmental Justice for Native American Communities](#)
 Janene Yazzie, Sixth World Solutions
- 10:20 am-10:40 am** [Resilience and Challenges for New Mexico Acequias](#)
 Paula Garcia, New Mexico Acequia Association
- 10:40 am-11:00 am** [Challenges and Opportunities for Irrigation Districts](#)
 Phil King, New Mexico State University
- 11:00 am-11:20 am** [Overview of the New Mexico Dynamic Statewide Water Budget](#)
 Sam Fernald, New Mexico State University
- 11:20 am-11:40 am** [Cultural Entrepreneurship as a Resiliency Strategy for Remote Communities: Lessons from Morocco, Canada and the USA](#)
 Olaf Kuhlke, University of Minnesota - Duluth
- 11:40 am-12:00 pm** [Development and Implementation of the 6p Resiliency Framework](#)
 Kami Norland, Integrative Re-Sources

12:00 pm-1:00 pm **Lunch with guest speaker Senator Tom Udall**

Session 3: A Vision for Building Resilience in Rural Systems

1:00 pm-1:45 pm [Panel #1: Rural Perspectives on Measuring and Building Resilience](#)

Panel Convener: Jami Nuñez, UNM Political Science

1:45 pm-2:45 pm [Breakout #1: Rural Perspectives on Measuring and Building Resilience](#)

2:45 pm-3:00 pm **Coffee Break in the Stamm Room**

Session 4: Resilience of Sustainable Urban Systems

3:00 pm-3:20 pm [A Tale of Two Cities: Exploring Sustainability and Resilience Opportunities and Challenges](#)

Melissa Bilec, University of Pittsburg

3:20 pm-3:40 pm [Developing Standards and Approaches for Urban Resilience: Case Study – Beirut, Lebanon](#)

Caroline Field, Arup

3:40 pm-4:00 pm [Assessing Drinking Water Utility Resilience in Large Cities Through Infrastructure and Institutions](#)

Julie Padowski, Washington State University

4:00 pm-4:20 pm [Returning Nutrients to Agriculture – A Role for Cities in a Circular Economy](#)

Jeremy Guest, University of Illinois – Urbana Champaign

4:20 pm-5:00 pm [Panel #2: Resilience of Energy Systems](#)

Panel Convener: Representative Abbas Akhil, New Mexico State House of Representatives, District 20

5:00 pm **Adjourn**

Wednesday, August 7th

8:00 am–8:10 am **Opening Remarks and Day 1 Recap (CEC Auditorium)**

Session 5: Learning from Change and Examples of Success

8:10 am–8:30 am **Drinking Water Underpins Rural and Urban Communities**

Heather Himmelberger, Southwest Environmental Finance Center

8:30 am – 8:50 am [Resilient Transportation Systems for Planned Special Events in Urban and Rural Contexts](#)

Claude Morelli, UNM Civil, Construction & Environmental Engineering

8:50 am–9:10 am [Restoring Fire to Build Resilience in Western US Forests](#)

Matt Hurteau, UNM Department of Biology

9:10 am–9:30 am [Partnerships for Landscape-Scale Resilience](#)

Lesli Allison, Western Landowners Alliance

9:30 am–9:50 am [The Rio Grande Water Fund: Creating Resilient Ecosystems and Communities in the Upper Rio Grande](#)

Collin Haffey, The Nature Conservancy

9:50 am–10:00 am **Coffee Break in the Stamm Room**

Session 6: A Vision for Building Resilience of Coupled Urban and Rural Systems

10:00 am–10:20 am [Building Resilience and Planning for Graceful Failure](#)

Karen MacClune, ISET-International

10:20 am–10:40 am [Resilience as a Lens for Governance](#)

Melinda Harm-Benson, University of Wyoming

10:45 am–11:45 am **Panel #3: Building Urban and Rural Systems Resilience**

Panel Convener: Thushara Gunda, Sandia National Labs

11:45 am-1:00 pm **Lunch in the Stamm Room**

Session 7: A Dialogue for a Path Forward

1:00 pm-2:00 pm

Breakout #2: Rural perspective on Measuring and Building Resilience

2:00 pm-2:50 pm

Panel #4: Bridging the Gaps Between Science, Policy, and Activism

Panel Convener: Brittany Fallon, The Sierra Club

2:50 pm-3:00 pm

Closing Remarks and path forward

3:00 pm-3:30 pm

Closing Coffee Break in the Stamm Room

3:30 pm

Adjourn

Appendix B: Resilience Colloquium Registered Participants

Last Name	First Name	Organization
Akhil	Abbas	NM State Legislature
Amestoy	Trevor	University of New Mexico
Anthony	Maya	Taos Land Trust
Atadero	Rebecca	Colorado State University
Atherton	Phleger	CAVU
Barish	Richard	Sierra Club
Bean	Anjali	Santa Fe County
Bean	Dora	University of New Mexico
Beene	Daniel	University of New Mexico
Begay	Chelsey	University of New Mexico Indigenous Design + Planning Institute
Beimer	Connie	University of New Mexico
Beloff	Beth	Coalition of Sustainable Communities NM
Bennett	Don	
Benson	Reed	University of New Mexico
Bernal flores	Bianca Guadalupe	Universidad de sonora
Beyer	Ashley	Congresswoman Xochitl Torres Small
Bhaskar	Aditi	Colorado State University
Bilec	Melissa	University of Pittsburgh
Bode	Christi	Moxiecran Media
Bogus	Susan	University of New Mexico
Braithwaite	Karl	Sierra Club
Brulotte	Ronda	University of New Mexico
Busch	Taylor	Center for Water and the Environment Civil Engineering
Cadol	Daniel	New Mexico Tech
Caplan	Todd	GeoSystems Analysis
Carman	Melendrez	University of New Mexico
Catron	Jolene	
Chaulagain	Smriti	University of New Mexico
Colvin	Tucker	
Coonrod	Julie	University of New Mexico
Cooper	Kenneth	University of New Mexico
Crawford-Garrett	Bryan	Thornburg Foundation
Crossey	Laura	Earth & Planetary Sciences University of New Mexico
Cruz	Maurice	South Central Climate Adaptation Science Center
Dan	Carter	NM WRRRI
De la cruz	Adriana	
Del Moral Zayas	Carlos Eduardo	Instituto Tecnologico de Hermosillo
Delker	Kimberly	University of New Mexico School of Engineering
DeVore	Cherie	University of New Mexico Dept. of CCEE
Dixon	Chyna	
Dufour-Allen	Genevieve	Johns Hopkins University
Ebner	Roger	Albuquerque Office of Emergency Management
El Hayek	Eliane	University of New Mexico
Ferenchak	Nick	University of New Mexico
FIELD	CAROLINE	ARUP
Garcia	Joe	University of New Mexico Chicana & Chicano Studies Dept.
Giesen	Lynette	U.S. Army Corps of Engineers
Glasenapp	Logan	New Mexico Wild
Gonzales	Estevan	NMDOT
Grace	Brian	New Mexico Museum of Natural History and Science
Gregory	Angela	University of New Mexico
Guest	Jeremy	University of Illinois at Urbana-Champaign
Gunda	Thushara	Sandia National Laboratories
Hadwiger	David	NMDOT Research Bureau
Harris	Cheryl	none- retired
Harris	Steve	Rio Grande Restoration
Harvey	Michael	NA

Hebard	Elaine	Sabias de Agua
Herman	Endito	NMDOT- D6
Heyne	Catherine	
Hicks	Jordy	Albuquerque Public Schools
Hirsch	Robb	Climate Change Leadership Institute
Hojati	Maryam	University of New Mexico
Holiday	Marticia	New Mexico Department of Transportation
House	Donna	Consultant
Howe	Kerry	University of New Mexico
Hurteau	Matthew	University of New Mexico
Huynh	Tammy	University of New Mexico
Jaramillo	Lauren	University of New Mexico
Jenniches	Isabelle	NM Healthy Soil Working Group
Jones	Amy	University of New Mexico
Jones	Michaela	University of New Mexico CWE
Karlstrom	Karl	University of New Mexico
King	James Phillip	NMSU
Kuhlke	Olaf	University of Minnesota Duluth
Ladwig	Laurel	University of New Mexico Geography & Environmental Studies
Lane	Maria	University of New Mexico
Leslie-Bole	Haley	Quivira Coalition
Llewellyn	Dagmar	Bureau of Reclamation
Llewellyn	Dagmar	Bureau of Reclamation
Lugo Acosta	Lizbeth	
Margaret	Ambrosino	
Marino	Margaret	New Mexico Museum of Natural History and Science
Marziliano	Adrian	University of New Mexico Water Resources Program
Mauermann	Paul	Sandia Mountain Natural History Center
McCarthy	Laura	NM Energy Minerals and Natural Resources Department
McCarthy	Patrick	The Nature Conservancy
Mcclintock	Cassy	University of New Mexico
Melgoza Gonzalez	Luis Guillermo	Universidad de Sonora
MEZA	MARIA	University of New Mexico
MILLER	LIZA	ARC PLANNING
Montano	Stephen	University of New Mexico
Moore	Aaron	CRP University of New Mexico
Moore	Maggie	NMDOT
Morelli	Claude	University of New Mexico
Morrison	Ryan	Colorado State University
Munoz	David	Renewable Taos
murrieta	oscar	universidad de sonora
Murrieta Yescas	Rafael	Instituto Tecnológico de Hermosillo
Naha	Cynthia	Santo Domingo Tribe
Navarro	Carlos	Bread for the World
Norland	Kami	Integrative Re-Sources
Oglesby	Adrian	University of New Mexico Utton Transboundary Resources Center
Ontiveros	Gabrielle	New Mexico First
Osinski	Marek	University of New Mexico
Padowski	Julie	Washington State University
palmer	joni	University of New Mexico
Papelis	Lambis	NMSU
Paskus	Laura	
Perea	Ernesto	University of New Mexico
Perea	Alissa	University of New Mexico
Phillips	Judith	JP Design
Pinson	Ariane	US Army Corps of Engineers Albuquerque District
Pope Jr	Harold	
Postel	Sandra	Global Water Policy Project

Praznik	Aljaz	University of New Mexico
Rinehart	Alex	New Mexico Tech
Roeder	Isela	University of New Mexico
Roychowdhury	Indu	University of New Mexico
Russo Baca	Stephanie	Utton Center
Rust	Lauren	Utton Center
Sanchez	Lucia	NM OSE/ISC
Sau	Nicolas	Universidad de Sonora
Savoca	Benjamin	
Schneider	Linden	Quivira Coalition
Schoener	Gerhard	SSCAFCA
Schroeder	Tim	University of New Mexico
Shadowwalker	Depree	AmeriCorps VISTA- Indigenous Design + Planning Institute
Shapiro	Fiana	Sandia Mountain Natural History Center
Stansbury	Melanie	NM State Legislature
Stark	Thomas	New Mexico Interfaith Power and Light
Stevens	Jens	USGS
Stevens-Rumann	Camille	Colorado State University
Stulberg	Sandra	Indivisible Nob Hill
Summers	Betsy	University of New Mexico
Taha	Mahmoud	University of New Mexico CCEE
Tallman	Sky	NMDOT
Tashjian	Paul	Audubon New Mexico
Thomas	Charles	SSCAFCA
Timmons	Stacy	NM Bureau of Geology & Mineral Resources
Tsinnajinnie	Lani	University of New Mexico
Unis	Carl	Sandia National Laboratories
Valdez	Joseph	University of New Mexico State of New Mexico
Van Osdel	Jennifer	RS21
VanDerGeest	Marie	Bohannon Huston Inc.
Velasco	Carmen A.	University of New Mexico
Wald	Marissa	Central New Mexico Community College
Webb	Ryan	University of New Mexico
Williard	Kara	Best Deal Retailer
Woldman	Bill	US Senator Tom Udall
Wynward	Todd	Taos Initiative for Life Together [TiLT]
Yazzie	Janene	International Indian Treaty Council
Zayas	Roberta	Office for Diversity equity & Inclusion/ Grad Student
Zubel	Nick	City of Albuquerque Office of Emergency Management
Zupan	Joseph	Amigos Bravos